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SOME FORAMINIFERA FROM WESTERN LONG ISLAND AND NEW YORK HARBOR

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This paper describes Pleistocene and Recent Foraminifera from western Long Island and New York Harbor. Very few Foraminifera occur in this region: six species of *Elphidium* and two species of *Rotalia*. The Pleistocene and Recent Foraminifera are identical.

The Foraminifera of Long Island and New York Harbor have not as yet, to my knowledge, been the subject of any published article. Feeling that my interest in the Foraminifera of Long Island may be shared by others, I have made them the subject of this paper, and have been spurred on in my research by the easy accessibility of this region.

The bottom muds of Jamaica Bay and of Lower New York Bay were the main sources of material. There came, also, an opportunity to add to these Recent muds some Pleistocene clay secured from the water supply tunnel built in Brooklyn during 1929 and 1930.

Material from the bottom was collected in water varying from one to forty feet in depth, for which special instruments were needed. The bottom sampler, here known as the "bulldog snapper," B in figure 1, plans for which were supplied by the Bureau of Fisheries, requiring as it does the jar of up and down impact to spring the jaws shut, was found impracticable for use from a moving boat or in deep ooze. Moreover, though it worked well from a stationary position such as a dock, bridge, or an anchored boat, its weight of fifty pounds, added to that of the waterproof containers necessary for carrying the wet mud, made it difficult to transport. The six-inch length of pipe designed by Dr. Albert Mann, and used by Mr. Paul S. Conger of the National Museum of Washington, to collect diatom material, suggested a simpler bottom sampler, A in figure 1, which consisted of a brass pipe twenty inches long, two and one-half inches in diameter, with a cap threaded on one end. This end of the pipe, as well as the cap, is pierced with one-eighth inch holes to allow the water to flow through and the muds to collect in the pipe. A bridle spans the distance from the leading edge to the center of gravity. The drag line snapped on and adjusted itself to the correct direction of pull for the depth of water. In use, the instrument was

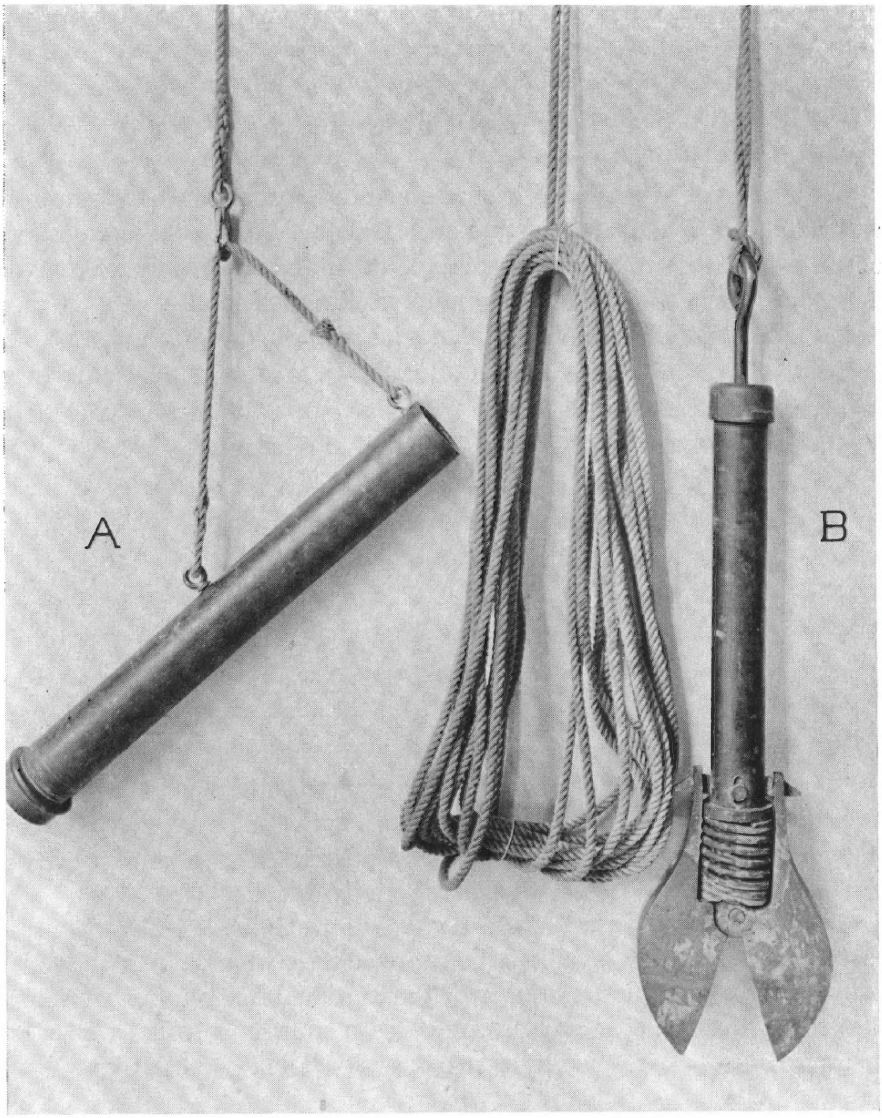


Fig. 1

tossed overboard, enough line paid out, and hauled in after a short time. This bottom sampler is light, stows easily, operates in all kinds of soft bottoms, and up to forty feet of water, which is the greatest depth in which it has been tried.

The samples from Jamaica Bay were collected from a seventeen-foot sloop. The samples from the bottoms of the creeks of Jamaica Bay were black mud, which washed easily, leaving a residue of small angular sand grains, glauconite grains, Foraminifera, gastropods, and fish teeth. The sandy parts of the Jamaica Bay bottom do not have any organic remains. The localities from which Foraminifera-bearing material was collected are plotted on the chart of New York Harbor, figure 2.

Mr. Charles M. Breder, of the New York Aquarium, offered the use of the Aquarium boat, the 'Sea Horse,' to get samples from New York Harbor. The crew coöperated in securing samples from the vicinity of Sandy Hook with the "bulldog snapper," the only bottom sampler then available. The localities dredged were plotted on the chart of New York Harbor, figure 2. The samples were sandy with a great many pelecypod fragments, among which were Foraminifera.

Drill samples from test bores in Raritan Bay, collected by the New York Port Authority in locating the piers for a new bridge, were turned over to me by Professor Charles P. Berkey, of Columbia University, for micropaleontological examination. Some of the drill samples contained a great many Foraminifera, a study of which is included in this paper. The location of the test borings is indicated on the chart, figure 2.

The Pleistocene clay secured with the help of Dr. H. R. Blank, geologist in charge of the City Tunnel No. 2 of the water supply system of New York City, was collected 150 feet below the surface of Hamilton Avenue in Brooklyn (Fig. 2, Station P). After the clay had been soaked for two days and then washed it was found to contain a great many pelecypod fragments, fish teeth, gastropod shells, and many Foraminifera.

The possibility that the salinity might vary and have an effect on the foraminiferal fauna induced me to determine the salinity of the water in Jamaica Bay and Sandy Hook. The salinity of waters from which Foraminifera were collected varied from 2.75 per cent in Jamaica Bay to 2.8 per cent at Station 4 and 3.3 per cent in New York Harbor and Sandy Hook. At the Jamaica Bay and Sandy Hook localities, which are about fifteen miles apart, specimens of Foraminifera were collected from two age levels, the Pleistocene and the Recent. Despite the variations of salinity and the distance apart from which specimens were

secured as well as the different ages, the Foraminifera were almost identical. The identity of the Pleistocene and Recent Foraminifera collected from the two localities is remarkable, moreover, because Station P is a subsurface bed of clay, generally supposed to extend

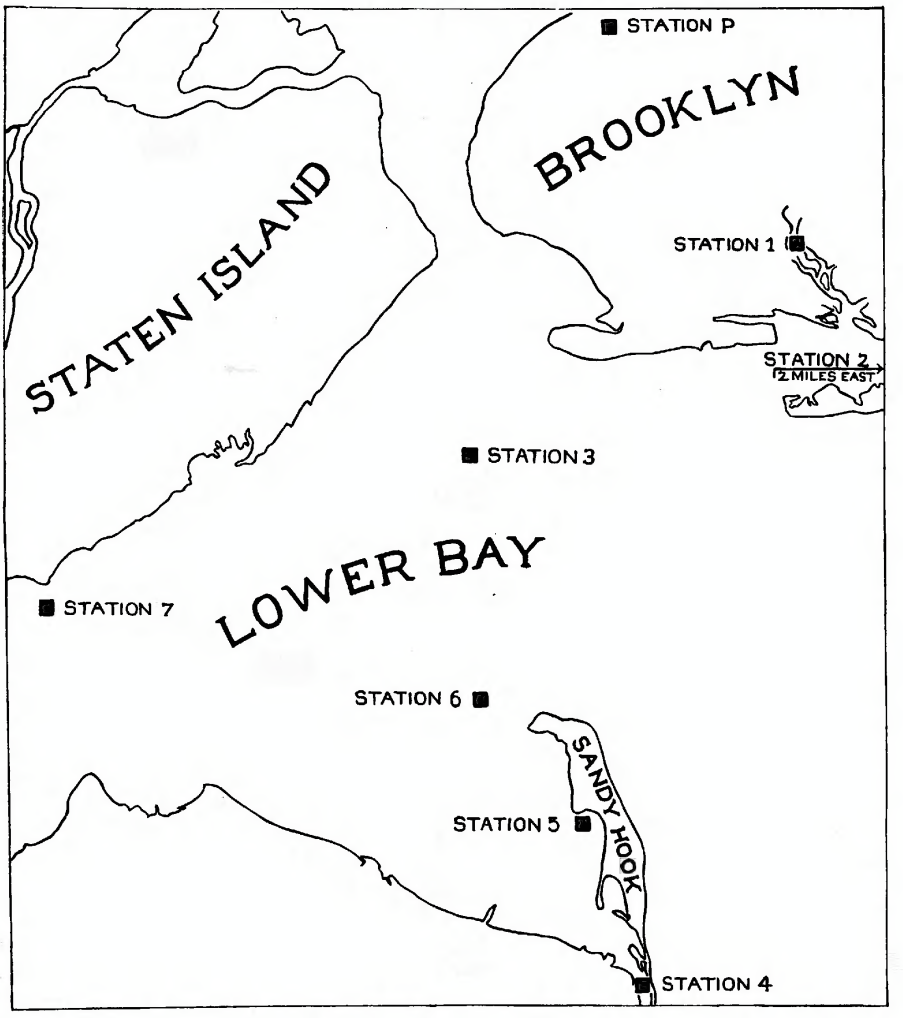


Fig. 2

throughout Long Island, lying between beds of sand and gravel. The identity of Foraminifera is notable also because Station 7 is a silted-in pre-Pleistocene river channel in Cretaceous sands covered by recent muds and sands. It might have been supposed that the great pollution of the waters of New York Harbor should have made a differ-

ence in variety of genera and species of Foraminifera collected from the different localities, but such is not the case. Should the Pleistocene and Recent groups taken from waters of varying salinity and purity be mixed, great difficulty would be encountered in identifying them individually. For this reason Foraminifera of this region differing in age level and locality will be discussed as one group.

The foraminiferal fauna seems limited to two genera and eight species: *Elphidium* (synonym *Polystomella*) with six species, of which two are new; and *Rotalia* with one species and a new variety of another species.

The holotypes and figured specimens are deposited in The American Museum of Natural History.

The figures for illustration were prepared by Miss Lee Barkman. Outlines were drawn with the aid of a camera lucida and checked by me.

I wish to acknowledge my indebtedness and appreciation to the following persons for their aid in the preparation of this paper: Mr. Hugo Leipniker and Mrs. Florentina Leipniker for translations of original descriptions in German and Latin and Miss Lee Barkman for her excellent illustrations.

Many more dredgings and collections of material were made than indicated by the eight stations listed below. It was thought best for the sake of simplicity and brevity to select a station representative of each locality.

Station 1.—Recent; north end of the dock at Watkins Canoe Landing at the head of Flatlands Creek. This creek is to be filled in shortly, in accordance with the improvement program of New York City.

Station 2.—Recent; the west side of Cross Bay Boulevard, one-half mile below Howard Beach.

Station 3.—Recent; just north of the West Bank lighthouse in Lower New York Bay.

Station 4.—Recent; Bennett's gasoline dock at Highlands, New Jersey.

Station 5.—Recent; inside the Horseshoe at Sandy Hook.

Station 6.—Recent; one and one-quarter miles west of Sandy Hook lighthouse, at some fish ponds.

Station 7.—Pleistocene; Hole number 4 of the Raritan Bay Bridge borings one-quarter mile south of Seguine point and 109 feet below sea level.

Station P.—Pleistocene; Shaft 17*a* of City Tunnel No. 2 of the Board of Water Supply of the City of New York at Hamilton Avenue, Brooklyn, and 150 feet below sea level.

RANGE TABLE

	Recent						Pleistocene	
	1	2	3	4	5	6	7	P
Rotalia beccarii var. *sobrina*	C	C	R	C	C	C	C	C
Rotalia repanda	N	N	N	N	N	N	N	R
Elphidium florentinae	A	A	N	C	C	C	C	C
Elphidium gunteri	C	C	R	C	C	C	C	C
Elphidium brooklynense	A	A	N	C	C	C	C	C
Elphidium clavatum	C	C	C	C	C	C	C	A
Elphidium discoidale	N	N	R	N	N	R	N	R
Elphidium incertum	N	R	R	N	C	C	C	R

A = abundant; C = common; R = rare; N = none.

ROTALIA Lamarck, 1804

Rotalia beccarii (Linné) sobrina, new variety

Figure 4, *a*, *b*, *c*

Not *Rosalina parkinsoniana* D'ORBIGNY, 1839, in De la Sagra, 'Hist. Fis. Pol. Nat. Cuba, Forams.,' p. 99, Pl. IV, figs. 25-27. (Recent.)

Rotalia beccarii (Linné) var. *parkinsoniana* CUSHMAN, 1930, 'Contrib. Cushman Lab. Forams. Res.,' VI, part 4, p. 100, Pl. XIII, figs. 14*a-c*. (Pleistocene, Maryland.)

Rotalia beccarii (Linné) var. *parkinsoniana* COLE, 1931, Florida Geol. Survey, Bull. 6, p. 49, Pl. III, figs. 5, 6. (Pleistocene and Pliocene, Florida.)

Test biconvex, coiled in a low spire, the dorsal side more convex than the ventral side; peripheral margin subacute; periphery entire; chambers nine to ten in the last whorl; sutures distinct, limbate, and flush with the surface; umbilicus with a large plug of clear shell material, sometimes with one or two smaller bosses; wall smooth, lustrous, with pores of medium size; aperture a slit at the base of the last chamber, between the periphery and the umbilical plug. Diameter, 0.30 mm. to 0.65 mm.; thickness, 0.15 mm., to 0.40 mm.

This variety is the same as figured and described by Cushman but does not seem to be *Rosalina parkinsoniana* D'Orbigny, whose figures show a lobulate margin, more nearly planispiral coiling, and the chambers are more closely appressed, more curved, and the sutures are not limbate.

This variety is found in both the Pleistocene and the Recent, though not of common occurrence, and differs from *R. beccarii* in smaller and more inflated chambers that are truncate toward the umbilicus, in the less limbate sutures, and in the adult form possesses a single umbilical plug, not one broken up into several bosses.

No typical full-grown forms of *R. beccarii* such as those found in the Adriatic occur in this region; all forms found are dwarfed or stunted and, since they occur at all stations and in all environments, they must be full-grown forms.

It is apparent, also, that the habitat has something to do with the particular characteristics, and that this variety is adjusted to the particular habitat in which it lives.

The holotype is in The American Museum of Natural History (Cat. No. A. M. N. H. 697).

Rotalia repanda (Fichtel and Moll)

Figure 3, *a*, *b*, *c*

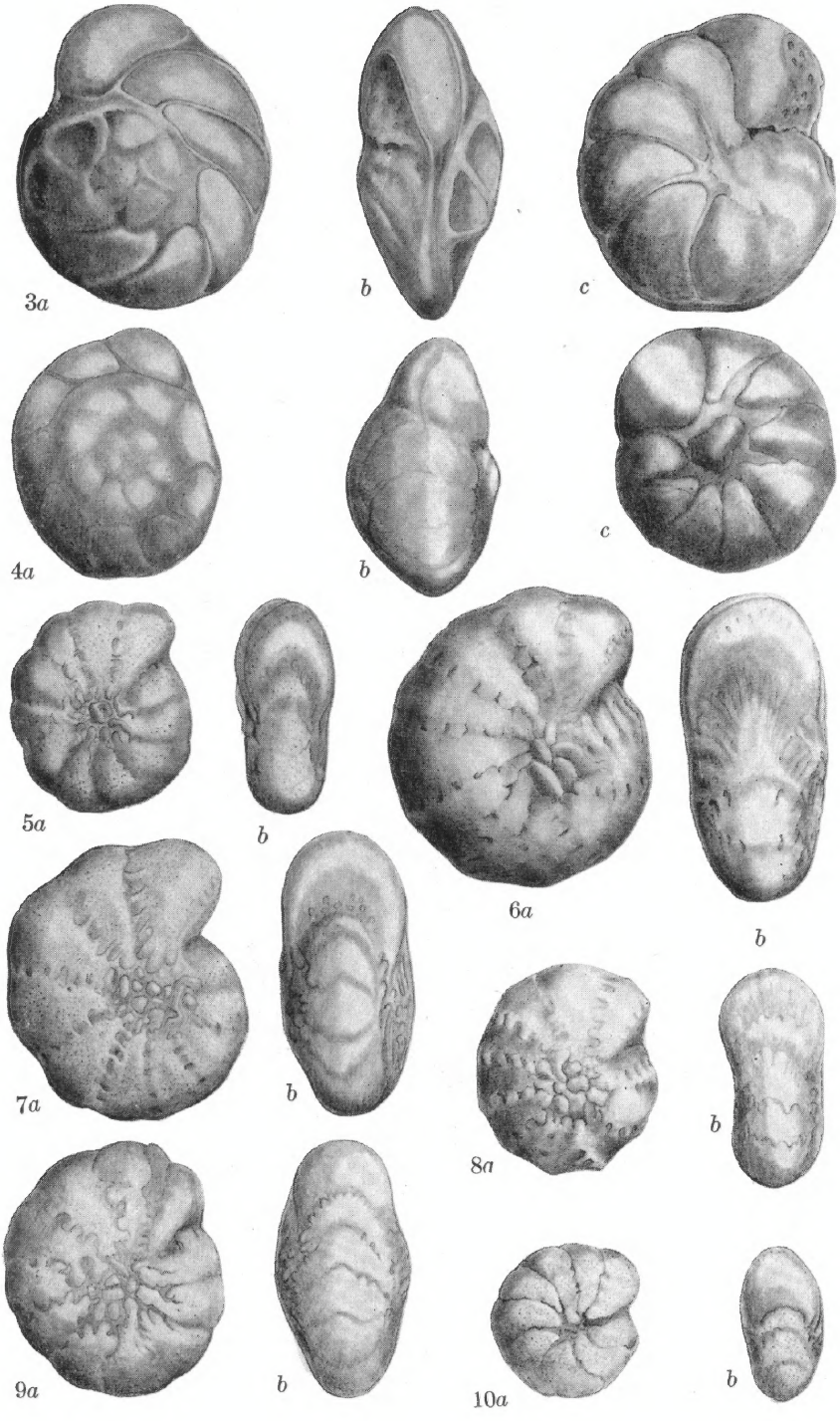
Pulvinulina repanda and *Eponides repandus* of authors. For synonomy, see CUSHMAN, 1931, Bull. No. 104, U. S. Nat. Mus., part 8, p. 49.

Test biconvex, more convex on the dorsal side, coiled in a spire; peripheral margin acute, periphery entire; chambers eight in the last whorl; umbilicus filled with the extension of the seventh chamber; sutures distinct, slightly depressed on the ventral side, slightly limbate on the dorsal side, the dorsal ones more curved than the ventral ones; wall smooth, very finely perforate; aperture a slit at the base of the last septum between the periphery and the umbilicus, widening toward the umbilicus, with large pores scattered over the septal face of the last chamber. Diameters: larger 1.2 mm., smaller 1 mm.; thickness, 0.40 mm. Occurrence: very rare in the Pleistocene in the vicinity of New York.

In identifying this form as *Pulvinulina repanda* and *Eponides repandus* two questions are raised:

1. Is this form generally recognized as *P. repanda* and *E. repandus* the same as Fichtel and Moll's *Nautilus repandus?*
2. Is *Eponides* a synonym of *Rotalia?*

Many authors have recognized the form here described as being the one described and figured by Fichtel and Moll as *Nautilus repandus.* But just what *N. repandus* is, is doubtful, for the original figures are not recognizable and the original description is hard to visualize. No known form has yet been found to correspond with Fichtel and Moll's figures. To really settle the question the original material would have to be reëxamined. The *P. repanda* and *E. repandus* of many authors seem to differ from the *N. repandus* of Fichtel and Moll in that the whorls are not involute on both sides; the sutures are not limbate on the dorsal


3a
b
c
4a
b
c
5a
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6a
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8a
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9a
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b

side; and there are large irregular pores on the septal face. To change the name of *E. repandus* of many authors would be pointless, since *E. repandus* has become established in the literature, and there is little likelihood of ever finding out what *N. repandus* really is.

The generic difference that supposedly separates *Eponides* from *Rotalia* is the absence of an umbilical plug. That this is a generic difference is doubtful, for many genera have species with and without the umbilical plug. The presence or absence of an umbilical plug is here regarded as a specific difference only.

The described and figured specimen is in The American Museum of Natural History (Cat. No. A. M. N. H. 702).

ELPHIDIUM Montfort, 1808

(Synonym: *Polystomella* Lamarck, 1822)

KEY TO SPECIES OF *Elphidium*

Umbilical region filled with bosses.
- Peripheral margin broadly rounded
  - Sutures of clear shell material, the last with pores or retral processes. ..... *E. florentinae.*
  - Sutures with pores and retral processes.
  - Sutures with pores.
    - All sutures with pores ..... *E. gunteri.*
    - With retral processes in last two sutures ..... *E. brooklynense.*
  - Sutures with retral processes ..... *E. clavatum.*
- Periphery subacute ..... *E. discoidale.*

Umbilical region without bosses ..... *E. incertum.*

Ephidium florentinae, new species

Figure 5, *a*, *b*

Test bilaterally symmetrical; peripheral margin rounded; periphery entire or slightly lobulate; umbilical region ornamented with bosses of clear shell material; chambers in the last whorl vary in number from nine to ten; usually nine, slightly inflated; sutures with wide bands of clear shell material, except the last two, which have a single row of pores; wall smooth, transparent, finely perforate; aperture composed of a number of round holes at the base of the apertural face. Diameter, 0.50 mm. to 0.70 mm.; thickness, 0.25 mm. Occurs frequently.

Fig. 3, *a*, *b*, *c*.—*Rotalia repanda* (Fichtel and Moll).
Fig. 4, *a*, *b*, *c*.—*Rotalia beccarrii* (Linné) *sobrina*, new variety.
Fig. 5, *a*, *b*.—*Elphidium florentinae*, new species.
Fig. 6, *a*, *b*.—*Elphidium gunteri* Cole.
Fig. 7, *a*, *b*.—*Elphidium brooklynense*, new species.
Fig. 8, *a*, *b*.—*Elphidium clavatum* Cushman.
Fig. 9, *a*, *b*.—*Elphidium discoidale* (D'Orbigny).
Fig. 10, *a*, *b*.—*Elphidium incertum* (Williamson).

This species would be a *Nonion* were it not for the pores that begin to appear indistinctly in the next to the last suture and show quite distinctly in the last suture. This characteristic is constant and shows in specimens collected fifteen miles apart. This species is much more abundant in samples collected close to shore and in less than ten feet of water.

This species is named in honor of my wife, Florentina Shupack, who has greatly assisted me in the collection of the material.

The holotype is in The American Museum of Natural History (Cat. No. A. M. N. H. 696).

Elphidium gunteri Cole

Figure 6, *a*, *b*

Elphidium gunteri COLE, 1931, Florida State Geological Survey, Bull. 6, p. 35, Pl. IV, figs. 9, 10. (Pliocene, Orange City, Florida.)

Test large; peripheral margin broadly rounded; periphery entire; the apertural face makes an angle of 136 degrees with the inner periphery; umbilical region flush with the surface, ornamented by clear bosses arranged regularly around a central boss; chambers are inflated and thirteen in the last whorl; sutures are distinct, marked by single rows of large pores five to seven in number; wall smooth, lustrous, perforate; aperture a series of small round holes at the base of the apertural face. Diameter, 0.90 mm.; thickness, 0.40 mm.

This species differs from *E. hughesi* Cushman and Grant in that *E. hughesi* has a lobulate margin and the umbilical region is slightly depressed. This species differs from *Polystomella poeyana* D'Orbigny in that the sutures do not reach to the minute umbilicus.

The described and figured specimen is in The American Museum of Natural History (Cat. No. A. M. N. H. 701).

Elphidium brooklynense, new species

Figure 7, *a*, *b*

Test very little compressed, bilaterally symmetrical; peripheral margin rounded; periphery entire or slightly lobulate; umbilical region filled with bosses irregularly arranged of clear shell material; chambers in the last whorl are usually nine in number; the last chamber is inflated; sutures are filled with large pores except for the last two, which are marked by retral processes, five to eight in number; wall smooth, transparent, finely perforate; aperture a number of round holes at the base of the apertural face. Diameter, 0.50 mm. to 0.80 mm.; thickness, 0.25 mm. Occurs frequently.

This species consistently has only the last two sutures ornamented with retral processes and in this respect differs from *E. gunteri* Cole. It seems to be the transitional form between *E. gunteri* and *E. clavatum.* It is numerous in samples collected close to shore in ten feet or less of water.

The holotype is in The American Museum of Natural History (Cat. No. A. M. N. H. 695).

Elphidium clavatum Cushman

Figure 8, *a*, *b*

Elphidium incertum (Williamson) var. *clavatum* CUSHMAN, 1930, Bull. 104, U. S. Nat. Mus., part 7, p. 20, Pl. VII, figs. 10*a*, *b*. (Recent, found in the 'Albatross,' dredgings in deep or cold water north of Hatteras, along the continental shelf.)

Elphidium incertum (Williamson) var. *clavatum* CUSHMAN, 1930, 'Contrib. Cushman Lab. Foram. Res.,' VI, part 4, p. 69, Pl. XIII, figs. 8, 9. (Pleistocene, Maryland.)

Test small; peripheral margin rounded; periphery entire or slightly lobulate; umbilical region ornamented by irregularly arranged bosses, very distinct but not forming an umbonate mass; chambers in the last whorl vary in number from nine to eleven, slightly inflated; sutures distinct marked by retral processes five to seven in number on each side; wall thick, opaque, with pores of medium size; aperture consists of several small round holes at the base of the apertural face. Diameter, 0.50 mm. to 0.80; thickness, 0.25 mm. Occurs in moderate number.

This species differs from *E. incertum* (Williamson) in that the chambers do not reach the minute umbilicus but consistently end in irregular bosses.

Although the description of the type specimen states that the umbilical region is not a definite umbonate mass, the figure of the type specimen shows a distinct umbo.

The described and figured specimen is in The American Museum of Natural History (Cat. No. A. M. N. H. 700).

Elphidium discoidale (D'Orbigny)

Figure 9, *a*, *b*

Polystomella discoidalis D'ORBIGNY, 1839, in De la Sagra, 'Hist. Fis. Pol. Nat. Cuba, Forams.,' p. 56, Pl. VI, figs. 23-24. CUSHMAN, 1922, Publ. 311, Carnegie Instit. Washington, p. 56, Pl. X, figs. 3, 4; 1926, Publ. 344, p. 80. (Recent.)

Elphidium discoidale (D'Orbigny), CUSHMAN, 1930, Bull. 104, U. S. Nat. Mus., part 7, p. 22, Pl. VIII, figs. 8, 9. (Recent, found in the 'Albatross' dredgings.)

Test biconvex; peripheral margin subacute; periphery slightly lobulate; the umbilical regions consist of large clear rounded bosses which protrude beyond the outline of the test in peripheral view; chambers inflated and twelve in last whorl; sutures distinct, slightly depressed, marked on each side by six to seven indistinct retral processes; wall smooth, transparent, perforate; aperture consists of several small round holes at base of apertural face. Diameter, 0.90 mm.; thickness, 0.40 mm.

This species differs from *E. discoidale* of Cushman in having two more chambers and fewer retral processes.

The described and figured specimen is in The American Museum of Natural History (Cat. No. A. M. N. H. 699).

Elphidium incertum (Williamson)

Figure 10, *a*, *b*

Polystomella umbilicatula var. *incerta* WILLIAMSON, 1858, 'Rec. Foram. Ct. Britain,' p. 44, Pl. III, figs. 82, 82*a*.

Polystomella striato-punctata var. *incerta* KIAER, 1930, Rept. Norwegian Fish Mar. Invest., I, No. 7, p. 51.—CUSHMAN, 1913, Rept. Canadian Arctic Exped., part M, p. 10.

Polystomella decipiens, HERON, ALLEN AND EARLAND (not Costa), 1916, Trans. Linn. Soc. London, (2) XI, p. 282, Pl. XLIII, figs. 20, 22.

Elphidium incertum CUSHMAN, 1930, Bull. 104, U. S. Nat. Mus., part 7, p. 18, Pl. VII, figs. 4-9. (Recent, Atlantic Ocean.)

Elphidium incertum CUSHMAN, 1930, 'Contrib. Cushman Lab. Foram. Res.,' VI, part 4, p. 96, Pl. XIII, figs. 6, 7. (Pleistocene, Maryland.)

Test compressed; peripheral margin rounded; periphery entire; umbilical region slightly depressed; chambers are ten in the last whorl; sutures distinct, meandering, depressed, marked by one or two retral processes; wall thick, opaque; aperture composed of several small round holes at the base of the apertural face. Diameter, 0.60 mm.; thickness, 0.25 mm.

The described and figured specimen is in The American Museum of Natural History (Cat. No. A. M. N. H. 698).